ARAZPA Amphibian Action Plan

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1. Background

Amphibian species across the world have declined at an alarming rate in recent decades. According to the IUCN at least 122 species have gone extinct since 1980 and nearly one third of the world's near 6,000 amphibian species are classified as threatened with extinction, placing the entire class at the core of the current biodiversity crisis (IUCN, 2006). Australasia too has experienced significant declines; several Australian species are considered extinct and nearly 25% of the remainder are threatened with extinction, while all four species native to New Zealand are threatened.

Conventional causes of biodiversity loss, habitat destruction and invasive species, are playing a major role in these declines. However, emergent disease and climate change are strongly implicated in many declines and extinctions. These factors are now acting globally, rapidly and, most disturbingly, in protected and near pristine areas.

Whilst habitat conservation and mitigation of threats *in situ* are essential, for many taxa the requirement for some sort of *ex situ* intervention is mounting.

In response to this crisis there have been a series of meetings organised by the IUCN (World Conservation Union), WAZA (World Association of Zoos & Aquariums) and CBSG (Conservation Breeding Specialist Group, of the IUCN Species Survival Commission) around the world to discuss how the zoo community can and should respond. A number of documents have been produced from meetings and workshops that provide a strong lead globally and regionally for the zoo industry to take action. These include (in chronological order):

- IUCN Declining Amphibian Populations Taskforce *Ex Situ* Conservation Advisory Group has produced draft Guidelines and Procedures for Management of *Ex Situ* Populations of Amphibians for Conservation: August 2005.
- Declaration of the Amphibian Conservation Action Plan (ACAP) arising from the Amphibian Conservation Summit in Washington, D.C., USA, in September 2005.
- CBSG/WAZA report on the Amphibian *ex situ* Conservation Planning Workshop in Panama, February 2006 (Zippel, *et al*., 2006);
- At its 2006 Annual Meeting in August, in Leipzig, Germany, WAZA adopted a resolution calling on the global zoo community to join with CBSG and the Amphibian Specialist Group to form, support, and develop an Amphibian Ark initiative to fulfil the *ex situ* components of the ACAP.

One of the key outcomes of these activities has been identification of the need for regional action plans to provide strategic direction and focus at the national or regional level. Following attendance at the Amphibian *ex situ* Conservation Planning Workshop in Panama, February 2006, Graeme Gillespie (Zoos Victoria, ZV) and Gerry Marantelli (Amphibian Research Centre, ARC) concluded that the current challenges facing Australasian frog conservation greatly exceeded current regional capacity to address them, let alone overseas challenges; and that if the Australasian zoo community were going to rise to any of these challenges, then it must build capacity and develop a plan of action locally. This strongly reinforced the previously discussed and agreed position of the ARAZPA Reptile & Amphibian Taxon Advisory Group (TAG).

2. Introduction

To date no regional planning has occurred in Australasia for amphibian *ex situ* management for conservation. A National Conservation Action Plan was produced by DEH (formerly Wildlife Australia) in 1996 (Tyler, 1997); however, this document provided little or no direction for *ex situ* management and conservation, and has never been updated. Similarly, a 1997 conference on the "Declines & Disappearances of Australian Frogs" pulled together a range of important presentations, but did not provide guidance on regional *ex situ* conservation action (Campbell, 1999). The recent IUCN Global Amphibian Assessment (see Stuart *et al*., 2004 and http://www.globalamphibians.org) and various State and Federal threatened species recovery plans have provided some direction and identified some priorities from the Australasian amphibian conservation community. It is clear from these documents and broader consultation with amphibian conservation biologists that the perceived need for various kinds of *ex situ* intervention has increased significantly in recent years. However, so far the response from Australasian zoological institutions has been limited. Individual zoos have responded to varying degrees, but not in the context of a regional approach (see various authors in ARAZPA, 2005).

This document is a strategic plan of action for ARAZPA institutions to respond to the current conservation crisis facing amphibians. Its intent is to provide direction for zoological institutions to increase their capacity in amphibian *ex situ* management in ways that maximise their ability to support amphibian conservation priorities.

This Plan has been prepared in consultation with the ARAZPA Reptile & Amphibian TAG, external regional and global expertise in *ex situ* amphibian management, and the broader amphibian conservation and research community.

3. Conservation status of Australasian Amphibians

At least 28 % of the 219 Australian frog species are threatened with extinction (Fig. 1). Three species are now believed to have become extinct in the last 30 years (Appendix I). At least 35 species are now considered Endangered or Critically Endangered. Based upon recent unpublished assessments, at least eight of these species are in imminent risk of extinction in the wild within the next decade, and indeed at least four of these species may already be extinct.

All of the four recognised taxa in New Zealand are considered threatened (http://www.conservation.co.nz/templates/MultipageDocumentPage.aspx?id=39585). Fiji has one Endangered and one Near Threatened species (http://www.globalamphibians.org). In Papua New Guinea (PNG) two species are recognised as Vulnerable and ten are Data Deficient.However, PNG also has numerous undescribed species, so these figures are conservative (Menzies, 2006).

Causes of amphibian declines are varied and include habitat destruction, invasive species (fish, mammals and cane toads), chytrid fungus and most likely climate change (see Campbell, 1999). Chytrid has been strongly implicated in many of the declines of species from relatively undisturbed upland habitats in the wet tropics and eastern and southern highlands of Australia (Berger *et al.*, 2004). However, in many cases multiple threats are implicated (Hero *et al.*, 2005, 2006). The bulk of reported declines have been in stream-breeding frog communities, alpine communities or species in upland areas. Some species in other areas and habitats have also declined, mostly due to habitat destruction and invasive species.

In New Zealand, invasive mammal species are believed to have had a big impact upon some species, although habitat loss has also played a role. Chytrid has also been strongly implicated in the decline of one mainland species, *Leiopelma archeyi*. The main threats in Fiji are invasive species such as mongoose and cane toads (Morrison, 2003).

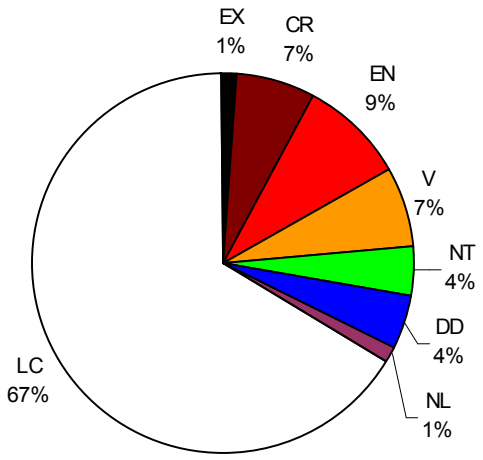

Figure 1. Summary of the conservation status of Australian amphibians. EX – presumed extinct; CE – Critically Endangered; EN – Endangered; VU – Vulnerable; NT – Near Threatened; NL – Not Listed; LC – Least Concern; DD – Data Deficient (Note: species in the Data Deficient category are unclassified and could occur in any of the previous categories of extinction risk).

The IUCN Global Amphibian Assessment (GAA) has identified 15 Australian species recommended for '*ex situ* intervention' and a further 11 species have been recommended by State or Federal recovery plans or recovery teams. In most cases, specific objectives for captive intervention have been identified as either captive breeding for re-introduction; insurance population, research or education/public awareness (Table 1). Twenty three threatened species have been identified as requiring captive intervention for insurance purposes; five species are identified as requiring captive breeding for re-introduction/translocation; twelve species for conservation-related research and five for education and community awareness.

In New Zealand insurance populations have been recommended for two species, with the potential to breed for release and approved non-invasive research, as directed by the Department of Conservation.

4. Current amphibian *ex situ* activities in Australasia

4.1 Species in Captivity

Australian ARAZPA institutions currently hold 35 native amphibian species. The ARC currently holds 40 species. The total number of species currently held in captivity in Australasia by these institutions is 50. One New Zealand endemic species is presently held in zoos; *L.*

archeyi at Auckland Zoo. ARAZPA institutions also hold eight exotic species. The Australian species held in captivity represent approximately 22% of the presently described Australian amphibian fauna. However, representativeness of the Australian amphibian diversity in some sort of *ex situ* management is poor (Fig. 2). Of 32 currently recognised genera and phylogenetic groupings within the large unresolved genus *Litoria*, only 12 are currently represented in captivity. Major gaps include: the entire Microhylidae family; the genera *Philoria* and *Taudactylus*, all of which are threatened with extinction or already extinct; the *Litoria nannotis* and *Nyctimystes* groups, which comprise all of the declining wet tropics tree frog species; and virtually all arid zone and dry tropics species.

The species held in ARAZPA institutions are also heavily biased towards species considered secure in the wild (Figs. 3 & 4), which are mostly common and widespread species that occur in the vicinity of Australia's major population centres. Of 26 threatened species recommended for some form of *ex situ* management, only 11 are currently held in any ARAZPA institutions (Fig. 4) and an additional two species are held by the ARC (Table 1).

Only 16 species have ever been bred in captivity by ARAZPA institutions. Most of these have only been bred successfully (captive mating and progeny raised to sexual maturity) by one or two institutions. With the exception of only a few species, these have been *ad hoc* breeding events. Several threatened species have been regularly bred successfully in various captive situations (zoos and private holdings) over the past 10-15 years. These include: the Green and Golden Bell Frog *Litoria aurea*, Growling Grass Frog *L. raniformis*, Spotted Tree Frog *L. spenceri*, Stuttering Frog *Mixophyes balbus*, and Red-crowned Toadlet *Pseudophryne australis*. Some success has also been achieved with *Geocrinia rosea*, the Southern Corroboree Frog *Pseudophryne corroboree* and Booroolong Frog *L. booroolongensis*. To date ARAZPA institutions have only successfully bred four of these species: *L. aurea*, *L. raniformis*, *M. balbus* and *P. australis* (Table 1, Fig. 4).

Historically, Adelaide University had a colony of Gastric Brooding Frogs, *Rheobatrachus silus*, but they were not maintained for conservation purposes and were not bred in captivity. Attempts were made in the early 1990's to secure the Sharp-snouted Torrent Frog *Taudactylus acutirostris* in captivity at Melbourne and Taronga Zoos, but this was before any knowledge of chytrid fungus, which killed all the animals (Banks & McCracken, 2002). Whilst some lessons may have been learnt from these experiences, the opportunity now appears to have been missed to secure some of these 'presumed extinct' species in captivity.

In summary, within the Australasian region further extinctions of numerous species (9 Critically Endangered and 24 Endangered) and increased endangerment of others (15 Vulnerable) are imminent. However, attempts to secure any of these species in captivity are very few (see Appendix I). In fact there is a strong bias in collections and captive management success towards species requiring the least, or no, *ex situ* conservation augmentation.

Table 1. IUCN-listed species recommended for *ex situ* intervention and their current *ex situ* status. Sources: IUCN GAA; various State and Federal Recovery Plans (published and unpublished); Recovery team representatives: Gerry Marantelli (ARC), David Hunter (NSW Dept. Environment & Conservation), Harry Hines & Keith MacDonald (Qld. Environment Protection Agency), Dale Roberts (University of WA); Helen Robertson (Perth Zoo). *Currently listed by IUCN as CE. Insur - insurance population; Reintro – captive breeding for reintroduction; Res – research program related to conservation; Edu – display for education and increased public awareness.

Species	IUCN Status	Recommendation IUCN	Recommendation Other	Purpose	Presently in captivity ARAZPA	Presently in captivity ARC	Presently in captivity Other	Captive-Bred
Geocrinia alba	CR		+	Insur; Re-intro; Res; Edu				
Litoria booroolongensis	CR		+	Insur; Re-intro	1	+		Not bred
Litoria castenaea	CR*	+		Insur				
Litoria lorica	CR*		+	Insur				
Litoria nyakalensis	CR*		+	Insur				
Litoria piperata	CR*	+		Insur, Res				
Litoria spenceri	CR	+	+	Insur; Re-intro; Res; Edu	2	+		F2+
Philoria frosti	CR	+		Insur; Res		+		
Pseudophryne corroboree	CR	+	+	Insur; Re-intro; Res; Edu	2	+		F1
Taudactylis acutirostris	CR*		+	Insur				
Taudactylis eungellensis	CR		+	Insur				
Taudactylis pleioni	CR	+		Insur; Res				
Taudactylis rheophilus	CR		+	Insur				
Litoria nannotis	EN	+	+	Insur				
Litoria raniformis	EN	+		Edu; Res	4	+	1	F2+
Litoria rheocola	EN		+	Insur				
Mixophyes balbus	EN		+	Insur; Res	1	+		F2
Mixophyes carbinensis	EN			Insur				
Mixophyes coggeri	EN			Insur				
Mixophyes fleayi	EN	+	+	Insur	1			Not bred
Mixophyes iteratus	EN	+		Insur; Res				
Nyctomystes dayi	EN		+	Insur				
Philoria richmondensis	EN	+		Insur				
Pseudophryne pengilleyi	EN	+	+	Insur; Res	1	+		Not bred
Crinia tinnula	VU		+	Research				
Geocrinia lutea	NT		+	Insur; Res	1			Not Bred
Geocrinia vitellina	VU		+	Res; Edu	+			
Litoria aurea	VU	+	+	Re-intro; Res; Edu	4	+	1	F2+
Litoria olongbrensis	VU		+	Res				
Spicospina flammocaerulea	VU		+	Insur; Res				
Taudactylus liemi	NT		+	Insur; Res				

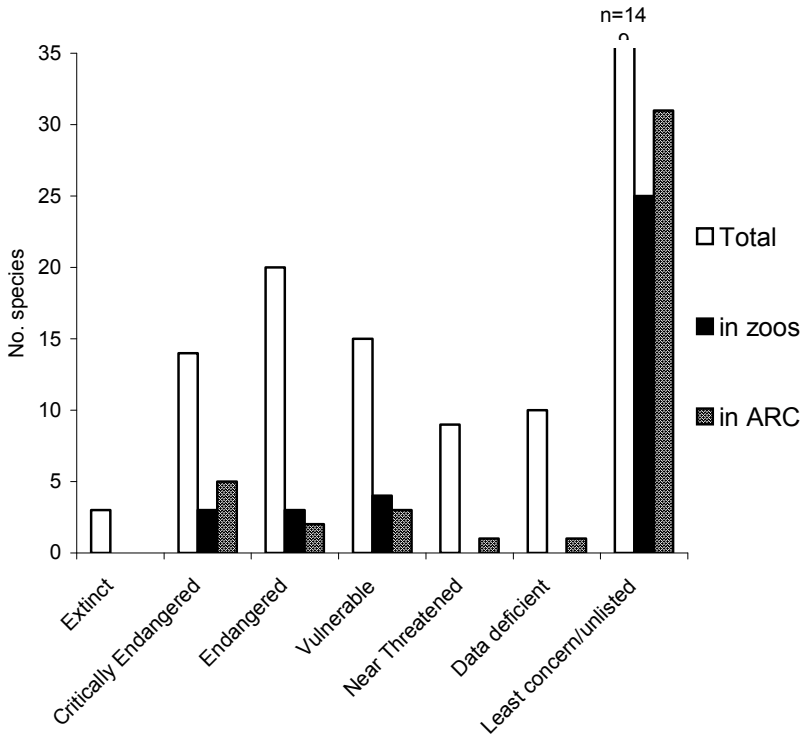

Figure 2. Number of species in each IUCN category currently held in ARAZPA institutions or the ARC.

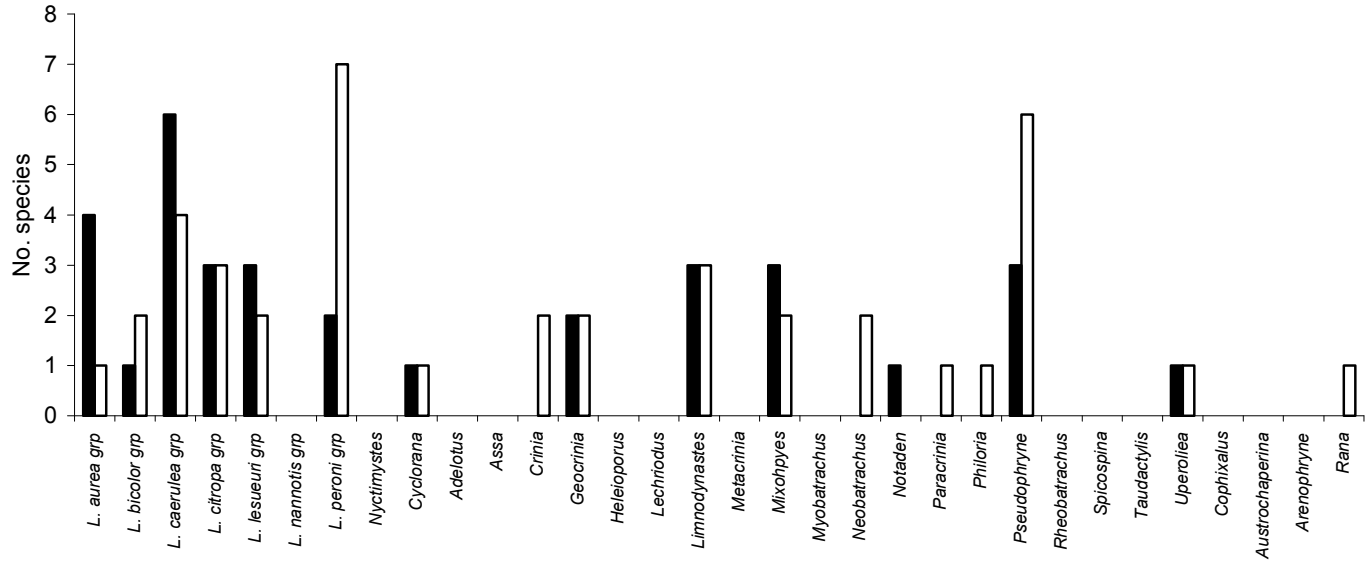

Figure 3. Current representation of Australasian amphibian diversity within zoological institutions. Phylogenetic diversity is represented either by genera or major phylogenetic groups within the genus *Litoria*.

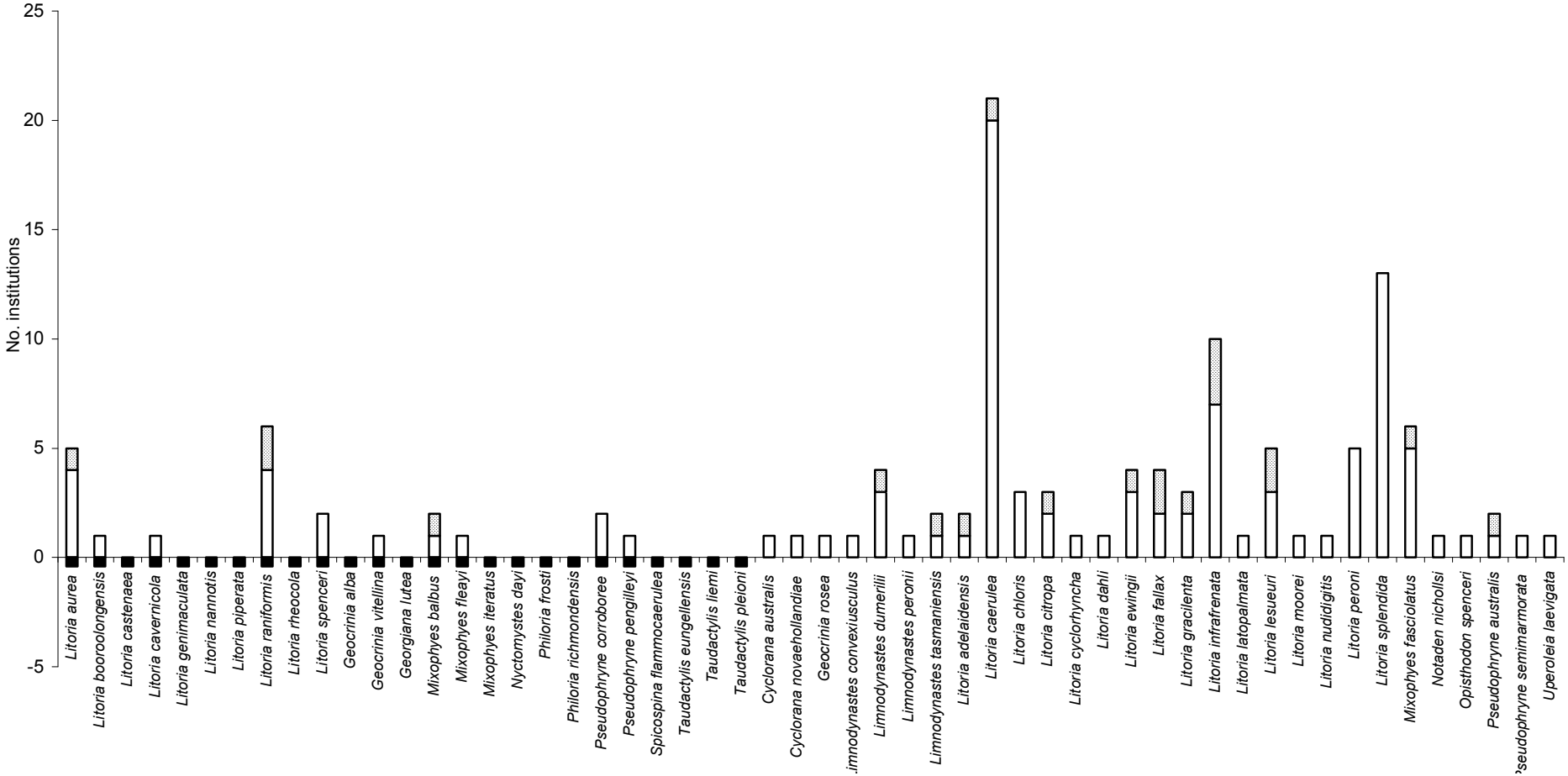

Figure 4. Relationship between species currently in ARAZPA institutions and identified need for *ex situ* conservation management of species in Australia. Species with identified need for *ex situ* conservation management are identified by black bars below the x axis; open bars – number of ARAZPA institutions holding species; stippled bars – number of institutions that have bred the species (breeding is defined as successfully raising captive-produced progeny to reproductive maturity).

4.2 Institutional Capacity

Based on the data submitted for the 2007 Regional Census and Plan, 32 ARAZPA institutions either hold native frogs now, or are planning to do so in the 2007-2008 year. These are located in two countries: 27 in Australia (6 in New South Wales, 6 in Victoria, 2 in South Australia, 1 in Western Australia, 2 in the Australian Capital Territory, 8 in Queensland and 2 in the Northern Territory); and 6 in New Zealand. The bulk of these (22) hold less than 5 species each, most of which are represented by less than 10 specimens of any species. With the exception of Melbourne Zoo, which currently holds 12 species (10 planned), the remaining institutions each hold 5-10 species.

Only five zoological institutions have dedicated[1] frog husbandry capacity in Australasia: Melbourne Zoo, Perth Zoo, Taronga Zoo, Tidbinbilla Nature Reserve in the ACT and Auckland Zoo. In addition, Healesville Sanctuary is currently constructing a breeding facility for the Spotted Tree Frog and Corroboree Frog. Apart from the ARC, these are also the only institutions with any involvement with threatened frog recovery programs, either through maintaining insurance colonies, supporting reintroduction programs, and research and display for education (Table 2). These are also the only institutions with staff having any demonstrable frog husbandry skills and experience. Presently, none of these institutions holds more than four threatened species. Further, none of them have the capacity to breed and hold large numbers of adults of more than any two species, as would be required for a robust captive breeding program.

In summary, the majority of institutions holding or planning to hold frogs have no, or very little, expertise in breeding frogs or maintaining large numbers of specimens. These institutions are principally geared to maintaining frogs for display, usually in small numbers. Present regional capacity and expertise to undertake *ex situ* management of threatened species is limited to a few larger institutions. Furthermore, these resources and available expertise are limited to only a few species. Husbandry experience is nonexistent for most of the more specialized Australasian amphibian life history modes.

[1] Facilities dedicated to breeding amphibians, staff with specific amphibian husbandry expertise, and clearly-defined husbandry and conservation objectives.

Table 2. Institutions currently involved with threatened frog conservation or research programs.

Institution	No. threatened species held	Insurance population	Captive breeding/rearing for re-introduction	Research (eg. husbandry or threat-abatement)	Display/ education/ interpretation
Auckland	1	*	*	*	*
Hamilton	1	*	*	*	*
Melbourne	3	*	*	*	*
Perth	2	*		*	*
Taronga	4	*	*	*	*
Tidbinbilla	1	*	*		
Healesville	1		*	*	*

5. Role of ARAZPA in the Amphibian Conservation Crisis.

There are a variety of ways that zoological institutions may contribute to amphibian conservation. However, to contribute meaningfully to amphibian conservation initiatives, *ex situ* captive management should form part of a recommended conservation/recovery action for a species, and be developed in consultation with appropriate government agencies, and be integrated with activities to research and manage threats in the wild. Furthermore, there must be clearly defined roles in the conservation of the species or its habitat.

The *ex situ* Conservation Advisory Group of the Declining Amphibian Task Force considers the following to be clearly definable conservation roles for the *ex situ* management of amphibian species:

i. *Ark:* An amphibian species that is extinct in the wild (locally or globally) and which would become completely extinct without *ex situ* management.

ii. *Rescue:* An amphibian species that is in imminent danger of extinction (locally or globally) and requires *ex situ* management as part of the recommended conservation action.

iii. *Supplementation:* An amphibian species for which *ex situ* management benefits the wild population through breeding for supplementation as part of the recommended conservation action.

iv. *Farming:* An amphibian species threatened through wild collection (e.g. as a food resource), which is being bred in captivity – normally in-country, *ex situ* - to replace a demand for wild harvested specimens. This category generally excludes the captive breeding of pet and hobbyist species.

v. *Conservation Research:* An amphibian species undergoing specific applied research that directly contributes to the conservation of that species, or a related

species, in the wild. This would include clearly defined 'model' or 'analogue' species.

vi. *Conservation Education*: An amphibian species that is specifically selected for management, primarily in zoos and aquariums, to inspire and increase knowledge in visitors, in order to promote positive behavioral change; for example, when a species is used to raise financial or other support for field conservation projects (this would include clearly defined 'flagship' or 'ambassador' species.).

Role 'iv' does not currently apply to Australasia, although it is conceivable that frog farming may commence in PNG in the future. With this exception, these roles provide clear guidance on how ARAZPA institutions may potentially contribute, through *ex situ* action, to amphibian conservation.

Furthermore, there are increasing levels of activity around *in situ* programs, such as population monitoring, research and habitat management. However, there are increasing limitations on resources available to conservation agencies and research institutions to meet these needs. As ARAZPA institutions build their amphibian expertise and roles in amphibian conservation programs, there are increasing opportunities for them to fill some of these gaps. Broader involvement with *in situ* activities will also facilitate integration of *ex situ* and *in situ* actions, and augment the development of interpretation and education.

5. Conservation Priorities

5.1 Regional Priorities

In Australia, it is clear that enormous gaps exist between the immediate and future needs of *ex situ* amphibian conservation and the capacity of ARAZPA institutions, either in terms of space, expertise or operating capacity. Although less significant, due to fewer species, this situation is paralleled in New Zealand. Therefore, if ARAZPA is going to make any meaningful contribution to amphibian conservation, it is essential that we focus upon closing these gaps within our region. We must get our own back yard in order before directing attention to other regions to avoid diluting what limited resources we have.

In the longer term, as we build our capacity in amphibian *ex situ* conservation and management, we may then consider other regional priorities. In these circumstances, South-east Asia would be the next highest priority. That region supports a large and diverse amphibian fauna, which, like all biodiversity in that region, is under immense pressures. In contrast to other global amphibian hotspots, such as Central America and north-east Australia, to date this region has received little attention from amphibian conservationists. However, pressures from habitat loss, over harvesting, invasive species and potentially emergent diseases are mounting. South-east Asia has been identified by WAZA and ARAZPA as a regional conservation priority for Australasian zoological institutions and ARAZPA zoos are already supporting *in situ* conservation programs in a number of South-east Asian countries.

Concerns surrounding disease risks will severely constrain future plans to undertake *ex situ* intervention of exotic species within Australasia. Any future support of international

programs will most likely be in the form of local research, *in situ* conservation and *ex situ* capacity-building.

5.2 Species Priorities

In PNG, the absence of zoological institutions possessing the necessary infrastructure and staff expertise prevents the development of *ex situ* management programs for PNG amphibians at this time. Moreover, the generally poor understanding of the status of PNG amphibians does not allow for meaningful prioritisation of either *in situ* or *ex situ* resources.

Because of the few native species present in New Zealand and Fiji, taxonomic priorities for *ex situ* intervention in those countries are relatively straightforward.

However, the amphibian assemblage of Australia is large and diverse and the conservation issues are more complex and challenging. It will not be possible for all the problems to be tackled at once; therefore priorities must be established.

At the CBSG/WAZA Amphibian *ex situ* Conservation and Planning Workshop in 2006, a tool was developed for the regional selection and prioritisation of taxa for *ex situ* conservation (Zippel *et al*. 2006; see Appendix II). This tool has been adapted to the Australian situation and used to establish *ex situ* conservation priorities for Australian amphibians. It is currently in draft form and it is anticipated that it will be refined in time. In the mean time, this assessment provides a meaningful guide to assessing priorities, but such assessment will need to be regularly updated.

As yet no formal process has been undertaken by the federal or State conservation agencies to systematically assess whether or not species require *ex situ* conservation action. Recommendations made during the IUCN GAA Australian assessment (in 2001) do not necessarily reflect the views of the various responsible conservation agencies and are now six years out of date. Accordingly, all species have been ranked here, irrespective of whether or not they have been recommended for *ex situ* conservation action previously. Furthermore, species presumed extinct have been included. In the unlikely event that any of these are rediscovered, *ex situ* intervention will need to be seriously considered.

Priority rankings are generally consistent with previous recommendations for *ex situ* conservation action (Table 3). Rankings are also generally consistent with conservation status, although other factors do play a significant role.

Table 3. Priority rank-order of species for *ex situ* conservation in Australia. A high rank means high priority. * Species potentially extinct.

Species	IUCN Status	*Ex situ* rec.	Rank Score	Species	IUCN Status	*Ex situ* rec.	Rank Score
Pseudophryne corroboree	CR	+	78	*Cophixalus mcdonaldi*	EN		29
Rheobatrachus silus	EX		72	*Cophixalus monticola*	EN		29
Rheobatrachus vitellinus	EX		72	*Cophixalus neglectus*	EN		29
Philoria frosti	CR	+	63	*Taudactylus liemi*	NT	+	29
Litoria castanea	CR*	+	60	*Crinia tinnula*	V	+	29
Litoria spenceri	CR	+	59	*Crinia sloanei*	DD		28
Geocrinia alba	CR	+	59	*Assa darlingtoni*	LC		22
Litoria raniformis	EN	+	59	*Cophixalus peninsularis*	DD		21
Litoria aurea	V	+	59	*Cophixalus zweifeli*	DD		21
Litoria booroolongensis	CR	+	57	*Litoria cavernicola*	DD		21
Taudactylus acutirostris	CR*	+	55	*Uperoleia arenicola*	DD		21
Taudactylus pleione	CR	+	55	*Uperoleia marmorata*	DD		21
Taudactylus diurnus	EX		55	*Uperoleia martini*	DD		21
Litoria lorica	CR*	+	52	*Uperoleia orientalis*	DD		21
Litoria nyakalensis	CR*	+	52	*Uperoleia tyleri*	DD		21
Nyctimystes dayi	EN	+	51	*Mixophyes fasciolatus*	LC		21
Geocrinia vitellina	V	+	51	*Cyclorana platycephala*	LC		21
Litoria verreauxi alpina	CR		50	*Geocrinia lutea*	NT	+	21
Pseudophryne pengilleyi	EN	+	50	*Litoria daviesae*	V		19
Taudactylus eungellensis	CR	+	49	*Litoria freycineti*	V		19
Taudactylus rheophilus	CR	+	49	*Litoria olongburensis*	V	+	19
Spicospina flammocaerulea	V	+	48	*Litoria subglandulosa*	V		19
Litoria piperata	CR*	+	47	*Litoria caerulea*	LC		16
Mixophyes fleayi	EN	+	45	*Crinia signifera*	LC		16
Mixophyes iteratus	EN	+	45	*Adelotus brevis*	NT		16
Heleioporus australiacus	V		43	*Arenophryne rotunda*	LC		15
Philoria kundagungan	EN		41	*Cophixalus aenigma*	V		15
Philoria loveridgei	EN		41	*Cophixalus hosmeri*	V		15
Philoria pughi	EN		41	*Cophixalus saxatilis*	V		15
Philoria richmondensis	EN	+	41	*Litoria jungguy*	NT		14
Philoria sphagnicolus	EN		41	*Geocrinia rosea*	LC		13
Mixophyes balbus	V	+	41	*Notaden nichollsi*	LC		13
Mixophyes carbinensis	EN		40	*Litoria chloris*	LC		13
Mixophyes coggeri	EN		40	*Heleioporus albopunctatus*	LC		13
Litoria nannotis	EN	+	38	*Heleioporus barycragus*	LC		13
Litoria rheocola	EN	+	38	*Heleioporus eyrei*	LC		13
Pseudophryne australis	V		34	*Heleioporus inornatus*	LC		13
Litoria andiirrmalin	V		34	*Heleioporus psammophilus*	LC		13
Cophixalus concinnus	CR		33	*Notaden bennetti*	LC		13
Litoria brevipalmata	EN		33	*Notaden melanoscaphus*	LC		13
Litoria cooloolensis	EN		33	*Lechriodus fletcheri*	LC		12
Pseudophryne covacevichae	EN		33	*Myobatrachus gouldi*	LC		12
Notaden weigeli	DD		31	*Litoria lesueuri*	LC		11

Table 3 contd.

Species	IUCN Status	*Ex situ* rec.	Rank Score	Species	IUCN Status	*Ex situ* rec.	Rank Score
Neobatrachus kunapalari	LC		11	*Cyclorana verrucosa*	LC		6
Neobatrachus pelobatoides	LC		11	*Limnodynastes depressus*	LC		6
Neobatrachus sudelli	LC		11	*Limnodynastes dorsalis*	LC		6
Litoria pearsoniana	NT		11	*Limnodynastes fletcheri*	LC		6
Pseudophryne bibroni	NT		11	*Limnodynastes interioris*	LC		6
Metacrinia nichollsi	LC		7	*Limnodynastes lignarius*	LC		6
Paracrinia haswelli	LC		7	*Limnodynastes peroni*	LC		6
Rana daemeli	LC		7	*Limnodynastes salmini*	LC		6
Cophixalus bombiens	NT		7	*Limnodynastes terraereginae*	LC		6
Cophixalus crepitans	NT		7	*Litoria ewingi*	LC		6
Cophixalus exiguus	NT		7	*Litoria paraewingi*	LC		6
Litoria barringtonensis	NL		7	*Litoria revelata*	LC		6
Litoria nudidigita	NL		7	*Litoria rubella*	LC		6
Cyclorana australis	LC		6	*Mixophyes schevilli*	LC		6
Cyclorana novaehollandiae	LC		6	*Neobatrachus albipes*	LC		6
Limnodynastes convexiusculus	LC		6	*Neobatrachus aquilonius*	LC		6
Limnodynastes tasmaniensis	LC		6	*Neobatrachus centralis*	LC		6
Litoria cyclorhyncha	LC		6	*Neobatrachus fulvus*	LC		6
Litoria dahli	LC		6	*Neobatrachus pictus*	LC		6
Litoria moorei	LC		6	*Neobatrachus sutor*	LC		6
Opisthodon spenceri	LC		6	*Neobatrachus wilsmorei*	LC		6
Limnodynastes dumerili	LC		6	*Opisthodon ornatus*	LC		6
Crinia bilingua	LC		6	*Litoria adelaidensis*	LC		6
Crinia deserticola	LC		6	*Litoria latopalmata*	LC		3
Crinia georgiana	LC		6	*Uperoleia laevigata*	LC		3
Crinia glauerti	LC		6	*Litoria citropa*	LC		3
Crinia insignifera	LC		6	*Litoria fallax*	LC		3
Crinia nimbus	LC		6	*Litoria gracilenta*	LC		3
Crinia parinsignifera	LC		6	*Litoria peroni*	LC		3
Crinia pseudinsignifera	LC		6	*Litoria infrafrenata*	LC		3
Crinia remota	LC		6	*Litoria splendida*	LC		3
Crinia riparia	LC		6	*Austrochaperina adelphe*	LC		3
Crinia subinsignifera	LC		6	*Austrochaperina fryi*	LC		3
Crinia tasmaniensis	LC		6	*Austrochaperina gracilipes*	LC		3
Cyclorana alboguttata	LC		6	*Austrochaperina pluvialis*	LC		3
Cyclorana brevipes	LC		6	*Austrochaperina robusta*	LC		3
Cyclorana cryptotis	LC		6	*Cophixalus infacetus*	LC		3
Cyclorana cultripes	LC		6	*Cophixalus ornatus*	LC		3
Cyclorana longipes	LC		6	*Geocrinia laevis*	LC		3
Cyclorana maculosa	LC		6	*Geocrinia leai*	LC		3
Cyclorana maini	LC		6	*Geocrinia victoriana*	LC		3
Cyclorana manya	LC		6	*Litoria bicolor*	LC		3
Cyclorana vagitus	LC		6	*Litoria burrowsae*	LC		3

Table 3 contd.

Species	IUCN Status	*Ex situ* rec.	Rank Score	Species	IUCN Status	*Ex situ* rec.	Rank Score
Litoria electrica	LC		3	*Pseudophryne dendyi*	LC		3
Litoria eucnemis	LC		3	*Pseudophryne douglasi*	LC		3
Litoria genimaculata	LC		3	*Pseudophryne guentheri*	LC		3
Litoria gilleni	LC		3	*Pseudophryne major*	LC		3
Litoria inermis	LC		3	*Pseudophryne occidentalis*	LC		3
Litoria jervisiensis	LC		3	*Pseudophryne raveni*	LC		3
Litoria littlejohni	LC		3	*Pseudophryne semimarmorata*	LC		3
Litoria longirostris	LC		3	*Uperoleia altissima*	LC		3
Litoria meiriana	LC		3	*Uperoleia aspera*	LC		3
Litoria microbelos	LC		3	*Uperoleia borealis*	LC		3
Litoria nasuta	LC		3	*Uperoleia capitulata*	LC		3
Litoria nigrofrenata	LC		3	*Uperoleia crassa*	LC		3
Litoria pallida	LC		3	*Uperoleia fusca*	LC		3
Litoria personata	LC		3	*Uperoleia glandulosa*	LC		3
Litoria phyllochroa	LC		3	*Uperoleia inundata*	LC		3
Litoria rothi	LC		3	*Uperoleia lithomoda*	LC		3
Litoria tornieri	LC		3	*Uperoleia littlejohni*	LC		3
Litoria tyleri	LC		3	*Uperoleia micromeles*	LC		3
Litoria verreauxi verreauxi	LC		3	*Uperoleia mimula*	LC		3
Litoria watjulumensis	LC		3	*Uperoleia minima*	LC		3
Litoria wilcoxi	LC		3	*Uperoleia mjobergi*	LC		3
Litoria xanthomera	LC		3	*Uperoleia rugosa*	LC		3
Pseudophryne coriacea	LC		3	*Uperoleia russelli*	LC		3
Litoria coplandi	LC		3	*Uperoleia talpa*	LC		3
Litoria dentata	LC		3	*Uperoleia trachyderma*	LC		3
				Uperoleia daviesae	NL		3

The high priorities are characterised by the following species or species groups and are dominated by stream-breeding species and montane and alpine species:

- The entire genus of *Taudactylus*, in particular *T. pleioni* and *T. rheophilus*, which are possibly the most endangered frogs in Australia at present;
- All of the threatened wet tropics endemic stream frogs (*Litoria nannotis*, *L. rheocola*, and *Nyctimystes dayi.*);
- Other subtropical and temperate stream species (*Litoria spenceri*, *L. booroolongensis*, *Mixophyes fleayi* and *M. balbus*);
- The entire genus of *Philoria* (the ARC has kept *P. frosti* in captivity for several years with no breeding success).
- Alpine and high-montane species.

These species should form the focus for maximum *ex situ* conservation effort.

Aside from extinct species, some ARAZPA institutions have already commenced *ex situ* programs on several of the highest priority species, namely: Southern Corroboree Frog *P. corroboree*, Green and Golden Bell Frog *L. aurea*, Growling Grass Frog *L. raniformis*, Spotted Tree Frog *L. spenceri*, and the Stuttering Frog *M. balbus*.

5.3 Analogue Species

Many of these species have relatively specialized ecological requirements that pose various challenges for *ex situ* management. Husbandry and captive breeding techniques have been developed for only a few species. These priorities must therefore be tempered by existing knowledge and institutional capacity. In some instances, it will be necessary to develop/trial husbandry on ecological analogue species as 'stepping stones' to more challenging and higher risk species. An example of this approach is the development of husbandry protocols at Melbourne Zoo for *Mixophyes fasciolatus*, with the sole aim of developing staff and institutional capacity to apply the skills and knowledge gained to more threatened species in the genus, leading to successful captive breeding of *M. balbus* (Banks *et al*., 2003). This approach has also been implemented by Perth Zoo on *Geocrinia* spp.

Institutions wishing to develop *ex situ* husbandry capacity for threatened species should consider the life history and ecological characteristics of the species, then endeavour to build programs around appropriate analogue species before tackling more challenging, higher risk, target species. For instance, the husbandry of several stream-breeding species, including some threatened species, has now been developed. Successful breeding programs for these species exist, either in zoos or the ARC. These species provide valuable analogues for developing skills, facilities and experience for other, potentially more challenging stream breeding species, such as *Taudactylus* spp.. Potential analogues for some threatened species are provided in Table 4.

Table 4. Priority threatened species and potential analogues.

Threatened target species	Potential analogue species
Pseudophryne corroboree	*Pseudophryne australis, P. dendyi* (already breeding in captivity)
Litoria booroolongensis	*Litoria lesueuri, L. wilcoxi*
Litoria spenceri	*Litoria citropa, L. lesueuri*
Taudactylus acutirostris	No congeneric analogues; other tropical stream-breeding species
Taudactylus eungellensis	No congeneric analogues; other tropical stream-breeding species
Nyctomystes dayi	No congeneric analogues; other tropical stream-breeding species
Mixophyes carbinensis	*Mixophyes balbus* (already breeding in captivity)
Mixophyes coggeri	*Mixophyes balbus* (already breeding in captivity)
Mixophyes fleayi	*Mixophyes balbus* (already breeding in captivity)
Pseudophryne covacevichae	*Pseudophryne australis, P. dendyi,* (already breeding in captivity)
Geocrinia alba	*Geocrinia lutea, G. rosea*
Geocrinia vitellina	*Geocrinia lutea, G. rosea*

Some species or genera, such as *Philoria* and *Taudactylus* spp, lack useful ecological analogues with lower conservation status, and due to their specialized life histories, pose significant captive husbandry challenges. At this stage, these species should only be considered for *ex situ* intervention by the most experienced institutions.

5.3 Broader Biodiversity Considerations

In view of the level of uncertainty around the status of many species within Australia and the high potential for increases in extinction risk to species in the future, it is essential that steps are taken to ensure that *ex situ* capacity is developed to assist in the conservation of the region's broader amphibian diversity. Therefore, in addition to species that have already been identified at high extinction risk and requiring *ex situ* conservation action, some effort should also be devoted to developing captive husbandry and breeding capability in other taxa representative of the region's amphibian diversity.

A number of monotypic genera exist in Australia with unusual biology or habitat specialisations, ie. *Arenophryne rotunda, Assa darlingtoni, Metacrinia nichollsi, Myobatrachus gouldi* and *Lechriodus fletcheri*. These species should be targeted for the development of *ex situ* management capability to ensure against its potential future need.

Some genera or phylogenetic groups are already represented within *ex situ* collections and captive breeding has been achieved for some species within them, such as the *Litoria caerulea*, *L. peroni*, *L. bicolor* and *L. aurea* complexes, and *Limnodynastes* spp. However, others are not and should be targeted, ie. *Adelotus, Cophixalus, Crinia, Cyclorana, Helieoporus, Neobatrachus, Notaden* and *Uperoliea*. Choices of species within these genera for developing captive management techniques should be informed by conservation status, ecological knowledge, educational/display potential and accessibility. The following species could be considered for example:

Crinia riparia	Stream-breeding species
Cyclorana platycephala	Captive-bred by ARC; displays well
Helieoporus australiacus	Vulnerable
Notaden weigeli	Data Deficient
Uperoliea tyleri/martini	Data Deficient

Table 5 summarises the highest priority species within Australia for *ex situ* conservation action, and the kind of actions needed/identified for each species and taxonomic group. All species that have been recommended for *ex situ* intervention are included, irrespective of rank.

5.4 Research

Many research questions relevant to amphibian conservation remain un-answered. Some of these are taxon-specific and others are more general, pertaining to taxonomic groups or regions. Captive management and breeding programs have the potential to play a vital role in supporting various research activities in these areas. This has already been demonstrated by the ARC, through the discovery of chytrid fungus, anti-fungacide research, and development of husbandry techniques and re-introduction trials.

Several endangered species recovery programs in Australia and New Zealand are at advanced stages and quite specific research objectives, relating to understanding impacts/interactions of threatening processes, are being addressed (eg. chytrid, introduced fish and salinity). Increasingly, these research projects are reliant upon experimental translocations, or captive breeding to produce stock or progeny for experimental re-introduction.

Ex situ management and breeding programs can contribute to the following areas of conservation research:

- Husbandry and reproductive biology.
- Experimental translocations.
- Development and evaluation of re-introduction programs.
- Clinical disease research.
- Assisted reproduction technologies.
- Provision of large numbers of individuals of species, otherwise unavailable in the field, for experimental research into causes of population decline.

Generally, research needs will be determined by relevant recovery programs or other conservation plans, such as the Amphibian Chytrid Threat Abatement Plan (Department of the Environment and Heritage 2006). These needs also should be considered when designing *ex situ* management programs and selecting species.

Table 5. Summary of Australian species and genera that should be targeted for various *ex situ* conservation-related actions. Threatened and Near Threatened species are in priority order; Least Concern (LC) species and genera are in alphabetical order.

Species/genus	IUCN status	Ark	Rescue	Supplementation	Research	Education	Husbandry development
Pseudophryne corroboree	CR	+	+	+	+	+	+
Philoria frosti	CR			+	+		+
Litoria raniformis	EN			+	+	+	
Litoria aurea	VU			+	+	+	
Litoria spenceri	CR	+	+	+	+	+	+
Taudactylus pleioni	CR	+	+		+		+
Litoria booroolongensis	CR	+	+	+		+	+
Pseudophryne pengilleyi	EN		+	+	+	+	+
Taudactylus acutirostris	CR	+					+
Taudactylus eungellensis	CR		+				+
Nyctomystes dayi	EN		+				+
Spicospina flammocaerulea	VU				+	+	+
Taudactylis rheophilus	CR	+					+
Litoria nannotis	EN		+		+	+	+
Litoria rheocola	EN		+		+	+	+
Mixophyes iteratus	EN		+			+	+
Mixophyes balbus	EN	+	+		+	+	
Mixophyes carbinensis	EN		+			+	+
Mixophyes coggeri	EN		+			+	+
Mixophyes fleayi	EN		+	+			+
Philoria richmondensis	EN			+			+
Philoria kundagungan	EN			+			+
Philoria loveridgei	EN			+			+
Philoria pughi	EN			+			+
Philoria spagnicolus	EN			+			+
Pseudophryne covacevichae	EN			+			+
Geocrinia alba	CR		+	+			+
Geocrinia vitellina	VU				+	+	+
Taudactylus liemi	NT					+	+
Geocrinia lutea	NT				+	+	+
Arenophryne rotunda	LC					+	+
Assa darlingtoni	LC						+
Lechriodus fletcheri	LC						+
Metacrinia nichollsi	LC						+
Myobatrachus gouldi	LC						+
Cophixalus spp.							+
Crinia spp.							+
Cyclorana spp.							+
Geocrinia rosea	LC						+
Helieoporus spp.							+
Litoria lesueuri	LC						+
Litoria wilcoxi	LC						+

Table 5. cont'd.

Species/genus	IUCN status	Ark	Rescue	Supplementation	Research	Education	Husbandry development
Litoria citropa	LC						+
Neobatrachus spp.							+
Notaden spp.							+
Pseudophryne australis	VU						+
Pseudophryne bibroni	NT						+
Pseudophryne dendyi	LC						+
Uperoliea spp.							+

6. Institutional capacity

6.1 Facilities

For ARAZPA to make a meaningful contribution to amphibian conservation, institutional capacity for amphibian *ex situ* management needs to be significantly increased. Due to the special needs of amphibians, this will require significant investment in terms of space, facility design and quarantine.

The priority amphibian taxa identified encapsulate a wide variation in life history traits. Many of these species have relatively specialized ecological requirements that pose a range of significant challenges for *ex situ* management. For instance, most of the endangered species are either stream-breeders or alpine species. These require sophisticated facilities that emulate riverine or alpine micro-environments. In some cases the husbandry and captive breeding requirements of these species have been developed, serving to highlight these challenges, which include, lighting, temperature, humidity, microhabitat structure, water flow and filtration, diet, and disease management. For most of these species, captive facilities necessary to breed species on scales necessary for long-term captive sustainability or re-introduction programs are large and sophisticated.

Relatively few ARAZPA institutions have the resources and expertise to respond to these needs at present. However, much expertise and experience in amphibian captive management exists within Australia at the ARC. The opportunity therefore exists to build upon this combined expertise and commence capacity building within ARAZPA. Furthermore, enough baseline information exists within the region to enable institutions to commence developing capacity by working upon analogue species, refining husbandry techniques and then applying these to endangered species programs.

In reality it is likely that this level of support will only be achievable by larger institutions within the region. Nevertheless, small institutions are also able to contribute to the overall ARAZPA amphibian conservation initiatives in a variety of valuable ways. They may be able to provide facilities to house, rear or showcase a species in support of an ARAZPA-managed conservation program. They may also be able to act as a shop front to provide education and provide up to date and factually correct advice about amphibians to the public; raise awareness about amphibian conservation issues; and generate support for recovery programs.

Due to the embryonic state of the knowledge base for most species, captive breeding facilities should be designed in ways that make them adaptable and enable experimental

husbandry to be undertaken; for example, through manipulation of environments. Some of the more advanced *ex situ* conservation programs, such as the Corroboree Frog and Spotted Tree Frog programs, now involve several zoo and non-zoo institutions. It is therefore essential that institutions develop and coordinate their activities and infrastructural designs.

6.2 Quarantine protocols

Amphibians intended for release to the wild need to be maintained in quarantine while in captivity. To prohibit the release of novel pathogens into free-range populations, quarantine protocols must be developed to eliminate the risk of introducing such pathogens into the captive population. Protocols should also include procedures to reduce the spread of pathogens within captive populations. Pathogen screening and treatment should occur while animals are in quarantine, on an annual basis and prior to release to other facilities. Prior to captive-exposed individuals being released to free-range populations, a percentage of the intended individuals should be euthanased and subjected to comprehensive pathogen screening. At present, various institutions have developed their own protocols for specific species and circumstances. To ensure Australian and New Zealand regional security, ARAZPA, in conjunction with the ARC and CSIRO Animal Health Laboratories, must develop a regionally agreed minimum set of quarantine protocols. The seriousness of this issue is well-recognised by wildlife agencies and the global amphibian conservation community, such as the 2001 meeting to develop national disease management strategies (Speare, 2001), and the development of a national Threat Abatement Plan by the Commonwealth Government (Department of the Environment and Heritage 2006). It is therefore incumbent on ARAZPA to adopt the same approach.

6.3 Development of expertise

Presently within this region there are few dedicated or experienced amphibian husbandry individuals. Due to the specific challenges that amphibians pose, it is necessary to develop and expand the level of husbandry expertise within the region in conjunction with the development of facilities. The Durrell Wildlife Conservation Trust (Jersey Zoo), in conjunction with the ARC, has developed a course on amphibian husbandry (Gupta, 2006). There are plans for this course to be operated within Australia. Staff involved with amphibian husbandry should be encouraged to undertake such courses and other training opportunities should be developed at larger zoological institutions with existing experience.

6.4 Collection management

Captive breeding protocols need to be developed for each of the high priority species or genera, in consultation with field biologists and experts familiar with the natural history of each species. Protocols need to be documented that detail essential seasonality and behavioural parameters to enable future replication. At a minimum, recorded information must include average monthly temperatures, detailed descriptions of enclosures and

maintenance schedules, light sources and annual light cycles, reproductive behaviour including barometric changes that may have influenced such behaviour, and growth and development morphometric data.

A proforma will be developed that stipulates the minimum information required to be documented for the development of robust husbandry protocols.

The principles that govern *ex situ* management of amphibians should be no different to those applied to any other taxa managed by ARAZPA. Presently, many amphibians maintained by zoological institutions are not part of captive management plans and do not have studbooks. It is essential that *ex situ* management of amphibians is undertaken in such a way as to maximise genetic diversity, animal health and adequate documentation for future reference. All species brought into captivity for *ex situ* conservation action should therefore be managed in accordance with current ARAZPA species management policies and guidelines.

7. Recommendations and Actions

The following recommendations are considered to be the immediate key priorities for ARAZPA, and reflect broad consultation across the amphibian conservation community. These three objectives provide a discrete and tangible set of high-priority actions for ARAZPA and other zoological institutions to focus upon.

1. *Develop a coordinated conservation and captive management program for the Southern Corroboree Frog,* Pseudophryne corroboree.

   The Corroboree Frog is one of Australia's most critically endangered species and has the strongest need for *ex situ* intervention. The NSW Department of Environment and Climate Change has requested ARAZPA institutional support with the implementation of the National Recovery Plan for this species (and the closely related Northern Corroboree Frog), which has explicit *ex situ* objectives. The ARC and three ARAZPA institutions (Melbourne Zoo, Taronga Zoo and Tidbinbilla Nature Reserve) are already participating in this program, thus providing the basis for developing a broad-based ARAZPA program.

   Due to its relatively high profile and striking appearance, the Corroboree Frog is an ideal flagship species for conservation. In conjunction to building a captive management program, an education, promotional and fund-rasing campaigns should therefore be developed, using the Corroboree Frog.

2. *Develop and expand ex situ captive management programs for stream-breeding species.*

   Stream-breeding species constitute the bulk of Australia's threatened species. However, they are poorly represented in zoological institutions and substantial capacity building is required to meet current and future potential husbandry needs. Captive management facilities should be developed with specific focus upon the Spotted Tree Frog (*Litoria spenceri*), Booroolong Frog (*L. booroolongensis*), and the Southern Barred Frog (*Mixophyes balbus*). These species are all high priority for *ex*

situ management. Populations already exists in zoos linked with National Recovery Programs and considerable husbandry expertise is already available for them.

In conjunction to building captive management programs, education, promotional and fund-rasing campaigns should also be developed around these species. This would be undertaken in conjunction with the Corroboree Frog program.

3. *Develop ex situ management capability for* Taudactylus *spp. and other Queensland wet tropics endemic species.*

   Many of the species requiring *ex situ* conservation intervention occur in Queensland. However, no endemic Queensland species are in any form of *ex situ* management and for many of them husbandry techniques have not been developed. The Queensland Government currently does not support any form of *ex situ* intervention in amphibian conservation recovery. However, in some cases this may be the only short-term solution for the survival of some species, such as *Taudactylus* spp. Therefore, ARAZPA, in conjunction with the ARC, will consult with the Environment and Protection Authority of Queensland to explore options for establishing threatened species management programs in Queensland institutions having the appropriate capacity and drawing on expertise available outside Queensland.

The following are more general recommendations for the region:

1. There are significant gaps between the Australasian regional needs for *ex situ* amphibian conservation action and ARAZPA's institutional capacity to meet those needs. Therefore, ARAZPA will devote its resources to bridging this gap, and focus on priorities for Australasian species, before channelling resources to programs/species outside of this region.
2. All actions and program development undertaken by ARAZPA zoos under the auspices of this ARAZPA Amphibian Action Plan will be coordinated/managed by the ARAZPA Reptile & Amphibian TAG, in close consultation with the ARC where appropriate. (This is at the broad, over-arching level, notwithstanding the specific references further in these recommendations).
3. ARAZPA institutions need to work in close coordination with their local state conservation agencies and proactively seek partnership with them in order to achieve mutually agreed outcomes. ARAZPA institutions should be encouraged to seek out and collaborate with local university researchers with expertise (or students) who could assist them in reaching ARAZPA goals.
4. Recognising the generally low level of amphibian expertise among staff in ARAZPA institutions, ARAZPA will strongly support and encourage initiatives to address this shortcoming as a high priority.
5. The priority species and taxonomic groups identified in Table 5 should be used as a basis for future planning and development of amphibian *ex situ* conservation activities within Australian zoological institutions. This list should be reviewed on an annual basis to ensure that priorities reflect current knowledge and needs.

6. New Zealand institutions should focus their attention upon New Zealand native species, working closely with the Department of Conservation and local researchers.
7. Individual ARAZPA institutions should explore opportunities to provide direct or indirect support to the identified priority programs. However, in doing so, zoological institutions should maximise opportunities for regional collaboration, not just amongst zoos but with all appropriate government and non-government conservation agencies, to maximise capacity and conservation outcomes.
8. The weight of evidence to date suggests that the emergence of chytrid fungus around the world probably resulted from the movement of African Clawed Frogs *Xenopus laevis* out of Africa for medical research. This phenomenon demonstrated that some diseases may be carried by host species that are resistant to those diseases. Knowledge and understanding of amphibian diseases is poor and more diseases are being discovered all the time, some of which are potentially serious. The potential still remains for pathogens to be moved around in resistant host species undetected by the most rigorous quarantine procedures. Once in a new environment they have the potential to infect naïve hosts, resulting in new waves of decline and extinction. Until further knowledge is available on amphibian pathogens and quarantine procedures to screen for them, no more amphibians will be imported into Australia or New Zealand or moved between countries within the region.
9. To ensure uniform/consistent regional biosecurity of all amphibian *ex situ* conservation programs, ARAZPA will consult with James Cook University, the CSIRO Australian Animal Health Laboratories, the relevant New Zealand agency and the ARC to develop a regionally agreed minimum set of quarantine protocols.
10. ARAZPA institutions will coordinate their efforts, in conjunction with the ARC, to develop best practice facilities to meet the needs of *ex situ* conservation actions as part of the recovery programs for priority species, and develop infrastructure husbandry capacity for broader amphibian biodiversity conservation.
11. All species brought into captivity for *ex situ* conservation action will be managed in accordance with current ARAZPA species management policies and guidelines. These programs will be designed and developed to be responsive to the specific needs of amphibian recovery conservation and research programs.
12. Through their broad engagement with the community; on-site, off-site and on-line; ARAZPA institutions should act as a 'shop front' for (1) raising awareness about the amphibian conservation crisis and its broader implications; (2) raising awareness about amphibian conservation activities locally and regionally; (3) connecting and involving people with relevant groups or activities in their communities; and (4) provision of factually correct advice to the public about amphibians and action that can be taken locally and regionally. This could be coordinated nationally to ensure consistency and efficiency.
13. The ARAZPA Reptile & Amphibian TAG, in consultation with the ARC, will develop a husbandry proforma that stipulates the minimum information required to be documented for the development of robust husbandry protocols.

14. ARAZPA will assist, wherever possible, government conservation agency-led *in. situ.* actions (such as experimental translocations) to conserve and recover species in the wild.

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Appendix I. Threatened and "Data-deficient" amphibian species in Australia (GAA 2007). * Potentially extinct. ** In other facility.

Species	IUCN Status	Recommendation for *ex situ* conservation		Presently in captivity (n = no. institutions)		*Ex situ* bred
		IUCN	Other	Aust. zoo	ARC	
Rheobatrachus silus	EX					
Rheobatrachus vitellinus	EX					
Taudactylus diurnis	EX					
Cophixalus concinnus	CR					
Geocrinia alba	CR		+			
Litoria booroolongensis	CR		+	1	+	
Litoria castenaea	CR*	+				
Litoria lorica	CR*					
Litoria nyakalensis	CR*					
Litoria piperata	CR*	+				
Litoria spenceri	CR	+	+	2	+	F2+
Philoria frosti	CR	+			+	
Pseudophryne corroboree	CR	+	+	2	+	F1 raised
Taudactylus acutirostris	CR*		+			
Taudactylus eungellensis	CR		+			
Taudactylus pleioni	CR	+				
Taudactylus rheophilus	CR					
Cophixalus monticola	EN					
Cophixalus mcdonaldi	EN					
Cophixalus neglectus	EN					
Litoria brevipalmata	EN					
Litoria cooloolensis	EN					
Litoria nannotis	EN	+	+			
Litoria raniformis	EN	+		4	+	F2+
Litoria rheocola	EN		+			
Mixophyes carbinensis	EN	+				
Mixophyes coggeri	EN	+				
Mixophyes fleayi	EN	+	+	1		F2
Mixophyes iteratus	EN	+				
Nyctomystes dayi	EN		+			
Philoria richmondensis	EN	+				
Philoria kundagungan	EN					
Philoria loveridgei	EN					
Philoria pughi	EN					
Philoria spagnicolus	EN					

Appendix I contd.

Species	IUCN Status	Recommendation for *ex situ* conservation		Presently in captivity (n = no. institutions)		*Ex situ* bred
Pseudophryne covacevichae	EN					
Pseudophryne pengilleyi	EN	+	+	1	+	
Cophixalus aenigma	VU					
Cophixalus hosmeri	VU					
Cophixalus saxatilis	VU					
Geocrinia vitellina	VU		+	1		
Crinia tinnula	VU					
Heleioporus australiacus	VU					
Litoria andirrmalin	VU					
Litoria aurea	VU	+	+	2	+	F2+
Litoria daviesae	VU					
Litoria subglandgulosa	VU					
Litoria freycineti	VU					
Litoria olongburensis	VU					
Mixophyes balbus	VU		+	1	+	F2+
Pseudophryne australis	VU			+		F2+**
Spicospina flammocaerulea	VU		+			
Adelotus brevis	NT					
Cophixalus bombiens	NT					
Cophixalus crepitans	NT					
Cophixalus exiguus	NT					
Geocrinia lutea	NT		+			
Litoria jungguy	NT					
Litoria pearsoniana	NT					
Pseudophryne bibronii	NT				+	
Taudactylus liemi	NT		+			
Cophixalus peninsularis	DD					
Cophixalus zweifeli	DD					
Crinia sloanei	DD					
Litoria cavernicola	DD					
Notaden weigeli	DD					
Uperoleia arenicola	DD					
Uperoleia marmorata	DD					
Uperoleia martini	DD				+	F2+
Uperoleia orientalis	DD					
Uperoleia tyleri	DD					

Appendix II

DECISION TREE FOR SELECTION AND PRIORITIZATION OF TAXA FOR *EX SITU* CONSERVATION

Compiled by Andrés Acosta, Kevin Buley, Verónica Cano, Jorge Garcia, Richard Gibson, Graeme Gillespie, Bob Johnson, Bob Lacy, Saskia Lafebre, Francisco J. López-López, César Molina, José Vicente, Rodríguez-Mahecha, and Tim Skelton

From: Zippel, K., R. Lacy, and O. Byers (eds.) 2006. *CBSG/WAZA Amphibian Ex Situ Conservation Planning Workshop Final Report.* IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, MN 55124, USA.

Rationale

Ex situ conservation and management of a threatened amphibian species should only be considered as an alternative when the absolute imperative of *in situ* amphibian conservation cannot by itself ensure the survival of a species and its ecosystem. An *ex situ* initiative should be viewed as just one of the tools that can help in the over-all conservation of a species. It therefore follows that strong links between *ex situ* and *in situ* components are fundamental to the long-term success of species conservation. Full integration between *in situ and ex situ* conservation approaches should be sought wherever possible. This is normally best highlighted through the establishment of a formal Species Action Plan/Species Recovery Plan that explicitly states the short-, medium- and long-term goals of each component of the conservation initiative. When *ex situ* management of an amphibian species is considered necessary and appropriate, the priority should be to establish the initiative within the range state of ecological origin. Emphasis should therefore be placed on developing appropriate capacity within the range state where this does not exist.

Data derived from *ex situ* management of amphibians should be made openly available to workers involved in the *in situ* conservation of the species (or similar species) and *vice versa.* In exceptional cases where an *ex situ* conservation initiative has been established prior to/in the absence of a concurrent *in situ* initiative (e.g. where a political situation prohibits it, or where a disease problem invalidates it), emphasis should be placed on establishing the appropriate *in situ* links as soon as it becomes possible to do so. The persistence of a species over the long-term is only assured by its conservation *in situ.* Therefore, an *ex situ* component to a conservation program should only ever be viewed as a short- or medium-term initiative, and its conservation aim should always be to render its own requirement superfluous!

This Decision Tree has been structured in three ‘phases.’ Phase One of the Decision Tree ensures that there is justification for an *ex situ* program. It consists of three fundamental questions with “yes” or “no” answers. These questions should be applied to the taxon under consideration, answering each honestly and objectively.

Phase Two of the Decision Tree takes those species that have ‘passed’ Phase One and attempts to prioritize them, i.e. with limited resources (space, staff, money, etc.), which species should have *ex situ* programs established ahead of others? It takes the form of a series of questions with weighted scores. The total score for a species indicates how

'important' an *ex situ* program for the species is in relation to others. Some questions may not be straightforward to answer and will require consultation with colleagues, taxonomic experts and other individuals/groups working with the species.

Phase Three of the Decision Tree considers the practical feasibility of initiating and maintaining an *ex situ* program once justified and considered a priority.

PHASE ONE: Initial Taxon Selection

Phase One of the Decision Tree is designed specifically to establish whether or not the justification exists to consider an *ex situ* program. Phase One does not consider issues of prioritization between taxa. It provides only a 'first cut' using yes or no answers. Only if a species makes it through Phase One, by answering 'yes' to both , should it be considered for an *ex situ* initiative. It should then be passed through Phase Two to determine the relative importance of the proposed program in relation to other species.

a) General Justification

1. Conservation role: Does the proposed *ex situ* initiative have a clearly defined role (see DAPTF conservation roles for the *ex situ* management of amphibian species) in the conservation of the target taxon or its habitat?

Yes: Go to 2.

No: Insufficient justification for an *ex situ* conservation component at this time. DO NOT CONTINUE.

2. Mandate: Is there an existing mandate (see Appendix 1) recommending the *ex situ* conservation of this taxon?

Yes: Go to Phase 2.

No: Insufficient justification for an *ex situ* conservation component at this time. DO NOT CONTINUE

PHASE TWO: Prioritization of Selected Taxa

Phase Two of the Decision Tree takes those taxa that have been selected for *possible ex situ* initiatives from Phase One and attempts to prioritize them. The questions should again be worked through sequentially, answered as objectively as possible and scores assigned. After all questions have been asked, a total score should be calculated to give a total species priority score.

b) Program Considerations

3. Threat mitigation: How potentially reversible are the threats currently facing the taxa in the short- to medium-term?

Prospect that threats can be reversed within 1-5yrs	Score 20
Prospect that threats can be reversed within 5-10yrs	Score 12
Threats may be reversible in unknown time frame	Score 4

No prospect of threat reversal	Score 0
Threats unknown*	Score 0

*Convey research need to Amphibian Specialist Group (ASG).

4. Primary Conservation role: What is the primary conservation role of the program for the target taxon? (as defined in Q.1/Appendix 2) N.B. Taxon may have more than one role, but only score the primary role:

Ark	Score 20
Rescue/Supplementation	Score 14
Conservation Research	Score 10
Farming	Score 6
Conservation Education	Score 0

c) Taxon Considerations

5. Extinction risk: What is the current IUCN Red List category for the taxon?

Critically Endangered	Score 20
Endangered	Score 16
Vulnerable	Score 12
Data Deficient*	Score 8
Near Threatened	Score 4
Least Concern	Score 0

*Taxon has been regionally or nationally recognized as ‘at risk’ despite data deficiency.

6. Phylogenetic uniqueness: e.g. is it a monotypic taxon?

Monotypic family	Score 10
Monotypic genus	Score 7
Species	Score 3
Sub-species	Score 0

7. Biological distinctiveness: e.g. does it exhibit a unique reproductive mode, unique physiology, etc., among the Class Amphibia?

Aspect of biology unique to species	Score 10
Aspect of biology shared with <6 other species	Score 5

No aspect of biology known to be exceptional	Score 0

8. Ecological significance: Does the taxon provide important ecosystem services?

Keystone species	Score 10
Principal component of ecosystem process	Score 7
Major component of ecosystem process	Score 3
Unknown	Score 0

9 . Cultural importance: Does the taxon have a special human value within its natural range or in a wider global context? For example, as a national or regional symbol, in an historic context, or as an 'iconic' amphibian species.

Yes	Score 5
No	Score 0

10. Socio-economic importance: Does the taxon have an economic value within its natural range (e.g. food, traditional medicinal or tourism), or have the capacity to function as an'umbrella' species?

Yes	Score 5
No	Score 0

11. Scientific importance: Is current or planned research, unrelated to the taxon's biology and taxonomy, dependent upon the taxon, e.g. human medical or conservation-related studies.

Research dependent upon species	Score 10
Research dependant upon <6 species (incl. this taxon)	Score 5
Research not dependant upon species	Score 0